

What is claimed is:

1. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means;

seatbelt attaching detecting means for detecting whether the seatbelt is attached to the occupant or disconnected from 10 the occupant; and

retraction limit detecting means for detecting whether the seatbelt has been retracted to a limit thereof;

wherein said control means controls said driving means in 15 a manner such that when said seatbelt attaching detecting means detects that the seatbelt has become attached to the occupant from a state in which it is disconnected from the occupant, the seatbelt is retracted, and when said retraction limit detecting means subsequently detects that the seatbelt has been retracted to said limit thereof, the seatbelt is 20 stopped from being retracted.

2. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means;

seatbelt protraction detecting means for detecting protraction of the seatbelt by the occupant;

10 seatbelt attaching detecting means for detecting attaching of the seatbelt to the occupant or disconnection of the seatbelt from the occupant;

bias force-imparting means for imparting a bias force to the seatbelt in a retracting direction;

15 seatbelt retraction detecting means for detecting
retraction of the seatbelt by said bias force-imparting means;
and

retraction limit detecting means for detecting whether
the seatbelt has been retracted to a limit thereof;

20 wherein said control means controls said driving means in
a manner such that when said seatbelt protraction means
detects the protraction of the seatbelt by the occupant after
said seatbelt attaching detecting means detects the attaching
of the seatbelt to the occupant, the seatbelt is protracted,
25 when the seatbelt retraction detecting means subsequently
detects the retraction of the seatbelt by said bias force
imparting means, the seatbelt is retracted, and when said
retraction limit detecting means detects that the seatbelt has
been retracted to said limit thereof, the seatbelt is stopped
30 from being retracted and then protracted for a predetermined
time period.

3. An automotive passenger restraint and protection
apparatus for an automotive vehicle, having a seatbelt, for
restraining an occupant of the automotive vehicle by the
seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting
and protracting the seatbelt;

control means for controlling said driving means;

seatbelt protraction detecting means for detecting
protraction of the seatbelt; and

10 seatbelt attaching detecting means for detecting whether
the seatbelt is attached to the occupant or disconnected from
the occupant;

15 wherein said control means controls said driving means in
a manner such that when said seatbelt attaching detecting
means detects that the seatbelt has become attached to the
occupant from a state in which it is disconnected from the
occupant or the seatbelt is held attached to the occupant, and
then said seatbelt protraction detecting means detects the
protraction of the seatbelt, followed by the seatbelt becoming

20 possible to retract, the seatbelt is retracted to a limit thereof and then protracted for a first predetermined time period, and then, after lapse of a second predetermined time period, the seatbelt is retracted to said limit thereof, said protraction of the seatbelt for said first predetermined time period and said retraction and protraction after the lapse of said second predetermined time period being carried out at least one time.

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4. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means; and

retraction failure detecting means for detecting retraction failure of the seatbelt;

10 wherein said control means controls said driving means to stop retracting the seatbelt when said retraction failure detecting means detects the retraction failure of the seatbelt.

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5. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means; and

doze indication detecting means for detecting an indication of doze of the occupant during driving of the 10 automotive vehicle;

wherein said control means controls said driving means to carry out alternately retraction and protraction of the seatbelt for a predetermined time period when said doze indication detecting means detects the indication of doze of

15 the occupant during driving of the automotive vehicle.

6. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means; and

rough road traveling notifying means for notifying said control means of traveling of the automotive vehicle on a rough road;

10 wherein said control means is responsive to notifying from said rough road traveling notifying means of traveling of the automotive vehicle on the rough road, for controlling said driving means to retract the seatbelt.

7. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means; and

doze prevention commanding means for commanding said control means to prevent dozing of the occupant during driving 10 the automotive vehicle;

wherein said control means is responsive to commanding from said doze prevention commanding means to prevent dozing of the occupant during driving of the automotive vehicle, for controlling said driving means to carry out alternately retraction and protraction of the seatbelt at irregular time 15 intervals.

8. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the

seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means;

10 seatbelt attaching detecting means for detecting attaching of the seatbelt to the occupant or disconnection of the seatbelt from the occupant; and

protraction stoppage detecting means for detecting stoppage of protraction of the seatbelt;

15 wherein when said protraction stoppage detecting means detects the stoppage of protraction of the seatbelt, said control means causes said seatbelt attaching detecting means to repeatedly carry out detection of attaching of the seatbelt to the occupant or disconnection of the seatbelt from the occupant, causes said protraction stoppage detecting means to repeatedly carry out detection of stoppage of protraction of the seatbelt, and when the stoppage of protraction of the seatbelt is detected by said protraction stoppage detecting means while the attaching of the seatbelt to the occupant is not detected by said seatbelt attaching detecting means, said control means controls said driving means to retract the

20 seatbelt.

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9. An automotive passenger restraint and protection apparatus for an automotive vehicle having doors, and a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;

control means for controlling said driving means; and

10 door opening/closing detecting means for detecting opening and closing of a predetermined one of the doors;

wherein when said door opening/closing means detects the opening of the predetermined one of the doors, said control means controls said driving means to carry out retraction of the seatbelt at a higher speed than when said door opening/closing means detects the closing of the predetermined

15 one of the doors.

10. An automotive passenger restraint and protection apparatus as claimed in claim 9, including vehicle reverse detecting means for detecting a reverse of the automotive vehicle, and seatbelt attaching detecting means for detecting attaching of the seatbelt to the occupant or disconnection of the seatbelt from the occupant, and wherein said control means inhibits said driving means from retracting the seatbelt when the attaching of the seatbelt to the occupant is detected by said seatbelt attaching detecting means, the opening of the predetermined one of the doors is detected by said door opening/closing detecting means and at the same time the reverse of the automotive vehicle is detected by said vehicle reverse detecting means.

11. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 an electric retractor having driving means for retracting and protracting the seatbelt;
control means for controlling said driving means;
collision danger detecting means for detecting danger of collision of the automotive vehicle;
10 wherein said control means controls said driving means to carry out alternately retraction and protraction of the seatbelt for a predetermined time period, based upon results of detection of the danger of collision by said collision danger detecting means when said collision danger detecting means detects the danger of collision of the automotive vehicle.

15 12. An automotive passenger restraint and protection apparatus as claimed in claim 11, wherein said control means controls a force of said driving means for retracting the seatbelt and a force of said driving means for protracting the

5 seatbelt by controlling said driving means based upon the results of detection of the danger of collision by said collision danger detecting means.

13. An automotive passenger restraint and protection apparatus as claimed in claim 11, wherein said control means controls a period of retraction of the seatbelt by said driving means and a period of protraction of the seatbelt by 5 said driving means by controlling said driving means based upon the results of detection of the danger of collision by said collision danger detecting means.

14. An automotive passenger restraint and protection apparatus as claimed in claim 11, including storage means for storing a state of use of the seatbelt, and wherein said control means stores at least one of the state of use of the seatbelt before a collision of the automotive vehicle and the state of use of the seatbelt after the collision, when said 5 collision danger detecting means detects the danger of collision of the automotive vehicle.

15. An automotive passenger restraint and protection apparatus as claimed in claim 14, including a power supply, and auxiliary power supply means for supplying power from said power supply to said control means for a predetermined time 5 period after a collision of the automotive vehicle, and wherein said storage means comprises a non-volatile ROM.

16. An automotive passenger restraint and protection apparatus for an automotive vehicle having an airbag, the apparatus having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the 5 occupant, comprising:

an electric retractor having seatbelt driving means for retracting and protracting the seatbelt;
airbag driving means for causing expansion of the airbag to restrain the occupant;

10 a pretensioner for rapidly retracting the seatbelt to restrain the occupant;

15 speed detecting means for detecting a speed of protraction of the seatbelt; and

20 control means for controlling at least one of actuation time or expansion pressure of the airbag by said airbag driving means, actuation time of said pretensioner, a force of said pretensioner for retracting the seatbelt, and a force of said seatbelt driving means for retracting the seatbelt, based upon the speed of protraction of the seatbelt detected by said speed detecting means.

5 17. An automotive passenger restraint and protection apparatus as claimed in claim 16, wherein said control means controls said airbag driving means to shorten the actuation time of the airbag when the speed of protraction of the seatbelt detected by said speed detecting means is higher than a predetermined value, and prolong the actuation time of the airbag when the detected speed of protraction of the seatbelt is lower than said predetermined value.

5 18. An automotive passenger restraint and protection apparatus as claimed in claim 16, wherein said control means controls said airbag driving means to decrease the expansion pressure of the airbag when the speed of protraction of the seatbelt detected by said speed detecting means is higher than a predetermined value, and increase the expansion pressure of the airbag when the detected speed of protraction of the seatbelt is lower than said predetermined value.

5 19. An automotive passenger restraint and protection apparatus as claimed in claim 16, wherein said control means controls said pretensioner to shorten the actuation time of said pretensioner when the speed of protraction of the seatbelt detected by said speed detecting means is higher than a predetermined value, and prolong the actuation time of said pretensioner when the detected speed of protraction of the

seatbelt is lower than said predetermined value.

20. An automotive passenger restraint and protection apparatus as claimed in claim 16, wherein said control means controls said pretensioner to decrease the force of said pretensioner for retracting the seatbelt when the speed of protraction of the seatbelt detected by said speed detecting means is higher than a predetermined value, and increase the force of said pretensioner for retracting the seatbelt when the detected speed of protraction of the seatbelt is lower than said predetermined value.

5 21. An automotive passenger restraint and protection apparatus as claimed in claim 16, wherein said control means controls said seatbelt driving means to increase the force of said seatbelt driving means for retracting the seatbelt when the speed of protraction of the seatbelt detected by said speed detecting means is higher than a predetermined value, and decrease the force of said seatbelt driving means for retracting the seatbelt when the detected speed of protraction of the seatbelt is lower than said predetermined value.

22. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 PWM signal generating means for generating a PWM signal; a motor for retracting and protracting the seatbelt, said motor having operation thereof controlled by said PWM signal generated by said PWM signal generating means; and determining means for detecting at least one of current flowing to said motor and terminal voltage across said motor and for determining a state of the operation of said motor, based upon the detected at least one of the current and the terminal voltage, said determining means having low-pass filter means having a predetermined cutoff frequency lower than a frequency of said PWM signal;

wherein said determining means causes said filter means to reduce higher frequency components than said predetermined cutoff frequency, contained in the at least one of the current and the terminal voltage, and determines said state of the 20 operation of said motor, based upon the at least one of the current and the terminal voltage having the higher frequency components reduced.

23. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 a reel shaft having the seatbelt wound thereon;
a motor for rotating said reel shaft in a direction of protracting or retracting the seatbelt;
motor stoppage detecting means for detecting stoppage of said motor, based upon results of a comparison between a value 10 of current flowing to said motor and a threshold value; and
control means for controlling said threshold value according to environmental conditions under which said motor is operated.

24. An automotive passenger restraint and protection apparatus as claimed in claim 23, wherein said threshold value is set to a value of the current flowing to said motor to be assumed when said motor has shifted from a rotatively driven 5 state to a stopped state, said threshold value being calculated based upon supply voltage applied to said motor.

25. An automotive passenger restraint and protection apparatus as claimed in claim 23, wherein said threshold value is set to a value of the current flowing to said motor to be assumed when a driving force of said motor is to be progressively decreased from a rotatively driven state, said threshold value being calculated based upon supply voltage applied to said motor, said control means progressively decreasing the driving force of said motor from a current

10 value, based upon the results of said comparison between the value of the current flowing to said motor and said threshold value.

26. An automotive passenger restraint and protection apparatus for an automotive vehicle, having a seatbelt, for restraining an occupant of the automotive vehicle by the seatbelt to protect the occupant, comprising:

5 a reel shaft having the seatbelt wound thereon;
a plurality of driving means for rotatively driving said reel shaft; and
10 driving force ratio determining means for determining a ratio of driving force between said plurality of driving
means.

5 27. An automotive passenger restraint and protection apparatus as claimed in claim 26, wherein said driving force ratio determining means includes pulse width adjusting means for adjusting a PWM signal delivered to said plurality of driving means, said ratio of driving force being determined by said pulse width adjusting means.

28. An automotive passenger restraint and protection apparatus as claimed in claim 26, including comparison means for driving one of said plurality of driving means and other driving means thereof with an equal driving force, and for comparing at least one of terminal voltage and pulsating components thereof between said one driving means and said other driving means, and abnormality diagnosis means for carrying out abnormality diagnosis based upon results of comparison by said comparison means.

5 29. An automotive passenger restraint and protection apparatus as claimed in claim 28, wherein said abnormality diagnosis means comprises determining means for driving said one driving means with a predetermined driving force and for determining whether the terminal voltage across said other

driving means or the pulsating components thereof show a value corresponding to said predetermined driving force.